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Methodologies for Equivalent Yield Calculation and their Implications for Property Investment Pricing

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Abstract*: Equivalent yield is a single discount rate that implicitly reflects the characteristics of a freehold property, as well as its redemption value and cash flow changes. Within the context of the synergy between equivalent yield analysis and the growth explicit discounted cash flow (DCF) techniques, this study assessed how the methodologies for equivalent yield calculation can influence the pricing of under-rented freehold property investments. Identified from existing literature were six techniques of equivalent yield calculation comprising the use of valuation and investment tables, formula method, linear interpolation, the @IRR-, and the goal seek functions in Microsoft Excel, and the use of mathematical software with in-built root-solving algorithm. These six methods were used to calculate the nominal net equivalent yield for a hypothetical case of under-rented freehold property. The decision rule for property pricing revolved around the net present value (NPV) criterion which is the difference between the market value of the property at the equivalent yield (PV_1) and the price paid for the same property (PV_0). The study demonstrated that mispricing of property might be attributed to the choice of methodology for the calculation of equivalent yield. It was found that equivalent yields derived from the spreadsheet- and polynomial root-solving approaches led to correct pricing of the property contrary to overpricing, which was attributed to equivalent yield derived from the linear interpolation method, and the phenomenon of underpricing associated with equivalent yields determined using valuation and investment tables, and the formula methods respectively. An added value of this study is that it has re-strategized the science of investment decision-making by identifying methodologies for processing investment data that would likely facilitate appropriate pricing decisions pertaining to the sale, purchase, or retention of under-rented freehold property investments.

Keywords: **Equivalent Yield, Discounted Cash flow, Net Present Value, Property Investment, Mispricing**

I. INTRODUCTION

There is a consensus among real estate scholars that the exercises of property investment valuation and property investment analysis deploy the same models and data input except that valuation answers the question of market expectation of exchange price of property, while investment analysis addresses the question of a property's worth to the investor [1-3]. In response to a combination of both existing and perceived risk associated with the purchase, sale, and retention of individual properties in a multi-asset portfolio, large scale investment funds have sustained the practice of conducting periodic valuations and analysis of specific underlying property assets. Notwithstanding, the reconciliation of pre-purchase and post-purchase computations of investors could be frustrated by imperfect knowledge of the market and the problem of imprecise prediction of cash flow and risk [4]; thereby leading to the mispricing of an investment property. In addition to these causes, the phenomenon of mispricing (comprising over-pricing and under-pricing) might be traced to the methodology deployed for calculation of the yield or internal rates of return (IRR) of the property in question.

Valuers and property investment analysts of the British extraction have asserted that property (real estate) investment exhibits two variant of internal rates of return (IRR), comprising the growth explicit IRR otherwise referred to as the equated yield and the growth implicit IRR otherwise called the equivalent yield [3, 5, 6]. Within the context of under-rented freehold investment properties, equivalent yield is the growth implicit internal rate of return which is used to capitalise both the current and reversionary cash inflows. For more than four decades, property scholars in the contemporary value school of thought have condemned the use of conventional techniques including the equivalent yield approach to the valuation of freehold investment property citing reverse yield gap, valuation errors, and changes in investors' expectation among other reasons [7-10]. With respect to the UK from where most commonwealth countries derive their understanding and practice of property valuation, a downturn has however appeared in literature indicating resilience of the conventional techniques comprising the all-risks yield (ARY) and the Equivalent Yield Techniques despite the prevalence of the contemporary value techniques [11-13].

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Property pricing over the years has been dominated by the use of explicit DCF techniques [1, 14]; the essence of which is to assist the investor to determine net worth of a purchase decision. Although valuers have remained resilient in the use of equivalent yield techniques [12], the test of a purchase decision might be explored by calculating the difference between the market value of property investment derived from the equivalent yield technique and the price paid/payable for the same property as derived from the growth explicit DCF appraisal. Therefore it is this perceived synergy between the use of growth explicit DCF and the Equivalent Yield analysis that motivated the need for this research.

Scholars in the contemporary value school of thought have asserted that equivalent yield technique favours property investment analysis as against property investment valuation [7, 8]. They further argued that equivalent yield techniques may engender mispricing of property, notwithstanding that practicing valuers have acclaimed the strength of this and other variants of the conventional value techniques towards producing a reasonably accurate estimate of market price [7]. Against this backdrop, an attempt was made in this paper to combine the analytical strength of the equivalent yield technique with that of the growth explicit discounted cash flow (DCF) technique in order to guide investment decisions pertaining to the sale and purchase of properties especially where an appropriate methodology for the accurate calculation of equivalent yield has been deployed.

This paper aims to assess how the methodologies for the calculation of equivalent yield tend to influence the pricing of under-rented freehold property investments. Specific objectives of this research include:

to examine the logical and conceptual justifications for the synergy between equivalent yield analysis and growth explicit DCF appraisals;

A. to evaluate existing methodologies for computing equivalent yield;

B. to evaluate the accuracy of equivalent yields determined from the variants of existing methodologies; and

C. To assess the implications of computed equivalent yields on property investment pricing.

It can be recalled that the application of variants of the conventional term and reversion- as well as the equivalent yield techniques have remained resilient in the UK property valuation practice [11-13]. On the other hand, the situation in Nigeria indicates how some valuers resort to valuing investment properties using contractors' method [15], while a reasonable sample of valuers who exhibit respect for the principles of valuation still preferred the conventional value techniques to say the least [9, 16, 17]. Following the evidence that some valuers in the UK and Nigeria still preferred the conventional value techniques, it may not be out of place to explore its synergy with growth explicit DCF when the appraisal of pricing decisions arise. The processing of property investment information is crucial to pricing decisions [18]. In view of studies according credence to the practice of calculating the difference between market price and market worth (underlying investment value) of a property [7, 11, 14, 18], there is a need to re-examine data input for such exercise among which is the equivalent yield, which may likely result to information asymmetry [2], and mispricing of investment property. Central to this study is the need to address incidence of mispricing likely to arise from the calculation and use of inaccurate equivalent yields. The value of this study include identification of methodologies likely to churn out reasonably accurate equivalent yield, as well as the synergy between equivalent yield analysis and the growth explicit DCF appraisal techniques for the purpose of evaluating pricing decisions of property investment funds, portfolio managers, and other interested institutional investors. Among other beneficiaries of this study include property investment valuation scholars and researchers.

II. THEORETICAL FRAMEWORK

A. Equivalent yield valuation

According to Brown and Matysiak [18], the equivalent yield model is the most common conventional method for valuing commercial property and analyzing current transactions.

This model of valuation is in two parts. The first comprises the contract rent up to the next rent review, while the second part of the valuation is predicated upon upward review to the market rent assumed to be constant in perpetuity. The metrics of equivalent yield valuation model is anchored on the equivalent yield, *y* the market rent, *R*, the contract rent, *c*, and the number of years to the next rent review, *n*. Valuation scholars identified two approaches to the equivalent yield valuation to include term and reversion approach (Fig. 1) and the layer approach (Fig. 2).

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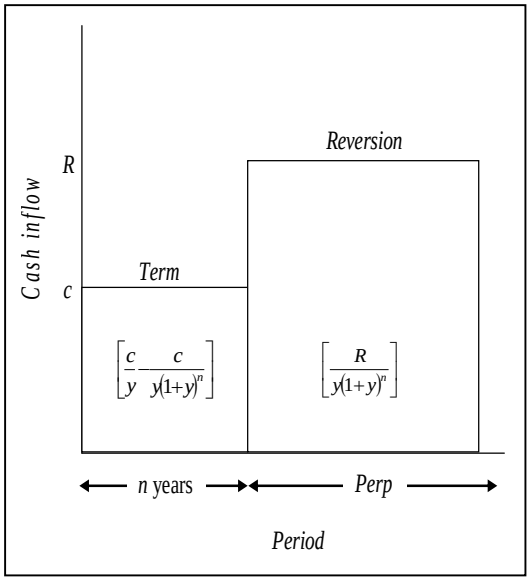

Fig. 1: Term and reversion approach to the Equivalent yield valuation model

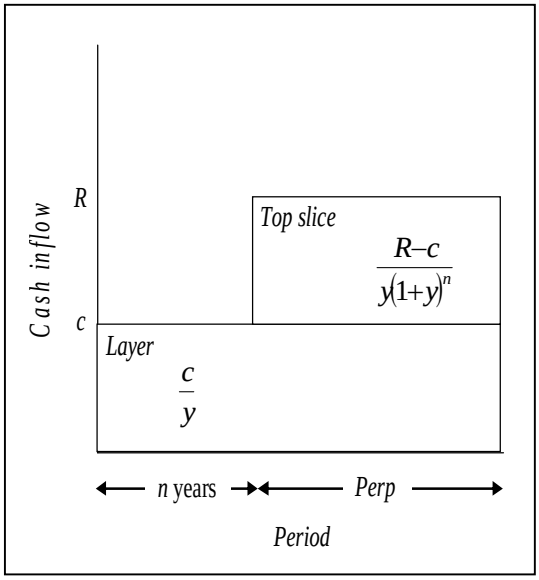

Fig. 2: Layer approach to Equivalent yield valuation model

The term and reversion approach (Fig. 1) comprises dual cash flows; the first being the contract rent for *n* years prior to the next rent review date, and the second cash flow being the market rent assumed to accrue to the investor in perpetuity. Using an equivalent yield, the sum of the discounted term- and reversionary cash flows equals the capital value, *CV* of the property as indicated in equation 1:

$$CV = \left[\frac{c}{y} - \frac{c}{y(1+y)^n}\right] + \left[\frac{R}{y(1+y)^n}\right] \tag{1}$$

$$PV_1 = c\left[\frac{(1+y)^n - 1}{y(1+y)^n}\right] + R\left[\frac{1}{y(1+y)^n}\right] \tag{2}$$

For the purpose of property investment pricing, Equation 1 is further rationalized to arrive at equation 2, which indicates that present value (PV_1) of term and reversionary tranches of cash inflows are products of specific net income multipliers and the applicable cash flows (See Fig. 1).

An alternative to the term and reversion method is the layer method of conventional valuation. Unlike the term and reversion method, layer approach values the contract- and market rents on the assumption that they are overlapping perpetual cash flows (Fig. 2). The first part of the valuation deals with the discounting of the contract rent to perpetuity, while the second part is the top slice income (marginal income) which is difference between the market rent, *R*, and contract rent, *c* assumed to continue to perpetuity. Equivalent yield valuation using the layer approach is the sum of perpetually discounted contract rent and the present value of the perpetual top slice income discounted back to its present value over *n* years. In principle, this approach is derived from equation 1 such that if *y* is the equivalent yield in the term and reversion approach, then the equation can be simplified as:

$$CV = \frac{c\cancel{(1+y)^n}}{y\cancel{(1+y)^n}} + \frac{R}{y(1+y)^n} - \frac{c}{y(1+y)^n} \tag{3}$$

$$PV_1 = \frac{c}{y} + \frac{R-c}{y(1+y)^n} \tag{4}$$

A short-cut method for valuing freehold properties using the equivalent yield model was demonstrated to include the sum of the capitalized market rent in perpetuity and the capital value of marginal rent deferred over the unexpired term [19]:

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$$PV_1 = \frac{R}{y} - \left[\frac{R-c}{y} - \frac{R-c}{y(1+y)^n}\right] \quad (5)$$

$$PV_1 = \frac{R}{y} - \frac{R-c\left\{(1+y)^n - 1\right\}}{y(1+y)^n} \quad (6)$$

Equation 5 is further simplified to arrive at equation 6 on the condition that $R - c$ retains its original meaning as the marginal income. These analogies imply that equations 1, 2, 4, 5 and 6 shall produce the same valuations. Valuers who favour the layer approach have attributed its use to the uncertainty confronting the receipt of market rent [4, 5, 19]. Notwithstanding, it has been argued that the market rent at the review date exhibits the same purchasing power as the current rental value [18].

B. Equivalent yield analysis

Within the context of conventional techniques of property investment valuation, Wyatt [3] defined equivalent yield as that single discount rate or internal rate of return that is used to capitalize the term and reversionary cash inflows of a property investment. The use of this single discount rate implicitly reflects probable income and value changes, and redemption value throughout the life of an investment [20]. In equivalent yield valuations, both the term and reversionary cash inflows are discounted using the same yield on the premise that the analysis of transactions can only churn out a single yield that captures the features of the market comparables as against the convention of intuitive segregation of term and reversionary capitalization rates [19, 21]. In other words, equivalent yield analysis produces only one feasible discount rate that is applicable to the valuation of both the term and reversionary tranches of property's cash inflow.

Equivalent yield analysis can be carried out to determine either the gross equivalent yield or the net equivalent yield. While the gross equivalent yield measures the growth implicit IRR of a freehold investment as the ratio of gross rent to capital value, the net equivalent yield measures the growth implicit IRR of the same investment property as the ratio of net rent to capital value. The difference between the duo is that the former is quoted on the basis of cash inflow prior to deductible recurrent expenses, while the latter is quoted on the basis of cash inflow after these recurrent expenses (including landlords' repairing obligations) have been deducted [22]; implying that for any given freehold investment property, the gross equivalent yield shall always exceed the net equivalent yield. Carrying out this study within the context of the Nigerian property market, emphasis was placed on the analysis of net equivalent yield given the use of net income multipliers as standard indices for the capitalization of cash inflows.

Furthermore, scholars have pointed out the need to differentiate between nominal equivalent yield and true equivalent yield. Nominal equivalent yield is the single discount rate (IRR) that is used to capitalize both the term and reversionary cash inflows receivable annually in arrears [19, 22]. In most cases, the calculation of equivalent yield is anchored the assumption of the receipt of cash inflows in arrears. However, an investment analyst can capture the actual timing of cash inflows in the analysis of value parameters in the bid to determine the true equivalent yield. Contrary to the nominal IRR, the true equivalent yield is the single discount rate (IRR) of the term and reversionary cash inflows receivable over specific periods that are distinct from the annually in arrears pattern. These specific periods may range from quarterly in advance to annually in advance. Following the receipt of rents in advance as practiced in Nigeria [9], this study attempts a conversion of the calculated nominal equivalent yield to the true equivalent yield expressed as an annual rate of interest in advance. The formula that can facilitate the conversion of nominal rate of interest to the true rate of interest is expressed as:

$$r = \left(\left(1 - \frac{y}{m}\right)^{-m} - 1\right) \quad (7)$$

In equation 7, r represents the true equivalent yield, y is the nominal equivalent yield, and m is the frequency of cash flow receipt in one year. Drawing an analogy from this and the preceding paragraph, equivalent yield analysis in this study revolves around the determination of nominal net equivalent yield (NNEY), which could easily be converted to the true net equivalent yield (TNEY) on the condition that m in equation 7 equals unity within the Nigerian context.

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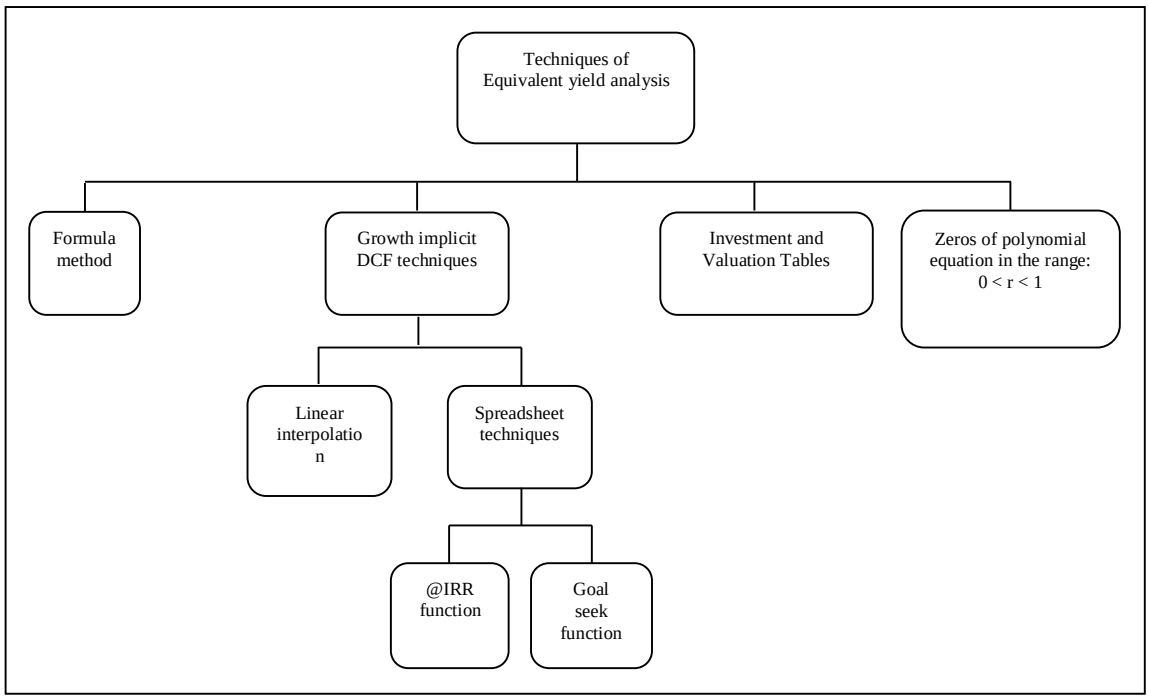

Fig. 3: Taxonomy of techniques for the calculation of Equivalent yield

Evidence from literature indicates six techniques for the analysis of the (nominal) equivalent yield (Fig. 3). These include equivalent yield analysis by formula [4, 5, 21]; growth implicit DCF techniques comprising linear interpolation [3, 4], the use of the @IRR function [3, 22], and the goal seek function in spreadsheets [22, 23]; and the use of Investment and Valuation Tables such as the Donaldson's Investment Tables or Parry's Valuation Table [5]. Additionally, a sixth technique is to find a single root of polynomial equation that represents the combination of term and reversionary cash flows and exhibiting a rationally feasible solution within the range: $0 < r < 1$ [18], where r is the equivalent yield (IRR). An accurate (nominal) equivalent yield should therefore return a Net Present Value (NPV) of zero when it is used to analyse the pricing decisions pertaining to under-rented freehold property investments.

Although Baum and Crosby [8] have argued that the coincidence of equivalent yields of two or more reversionary freeholds with varying investment parameters and located in the same neighbourhood adds little or no credit to the analysis of comparables, it is worthy of note that such comparable analysis might critically influence property investment pricing. In other words, equivalent yield technique of valuation can exert influence on equivalent yield analysis and vice versa notwithstanding that these constitute two distinct exercises. In addition, the accuracy of the equivalent yield in question might be critical to the outcome of pricing decisions - a phenomenon that is better demonstrated using a synergy of growth explicit DCF appraisals and equivalent yield analysis.

C. Property investment pricing.

Price formation is engendered during the bidding process between buyers and sellers in the property market with support from market information and investment market parameters [18]. Therefore, pricing mechanism for property investment entails the interaction between the forces of demand and supply towards determining the equilibrium price. The determination of value-in-exchange for property assets is subsumed in the figure which is a proxy for price agreed by parties to a transaction (equilibrium price).

Fig. 4 explains how the property market creates prices and allocates space to tenants and purchasers of interest in land. With respect to the outskirts of urban areas in developing countries, supply of landed property, *ss*, is relatively inelastic such that at the initial demand curve d_0d_0, an equilibrium point e_0 is defined by coordinates (Q_0, P_0). An increase in demand from d_0d_0 to d_1d_1 leads to a change of equilibrium quantity from $0Q_0$ to $0Q_1$ with a corresponding price increase from $0P_0$ to $0P_1$ at equilibrium point e_1.

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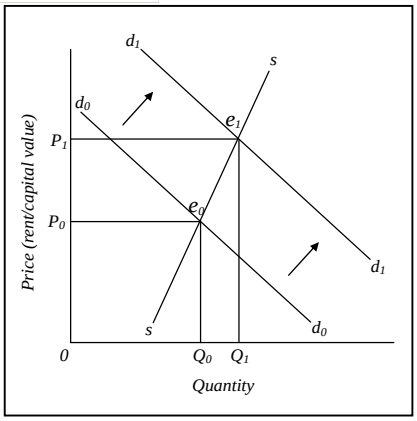

Fig. 4: Static pricing of property with relatively

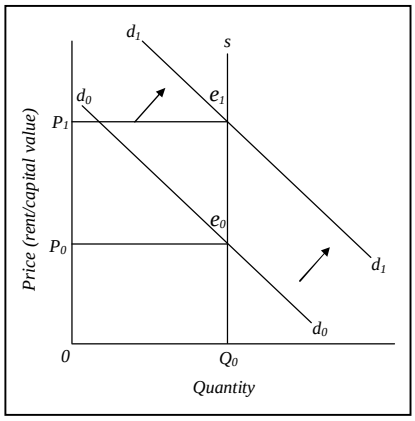

Fig. 5: Static pricing of property with perfectly

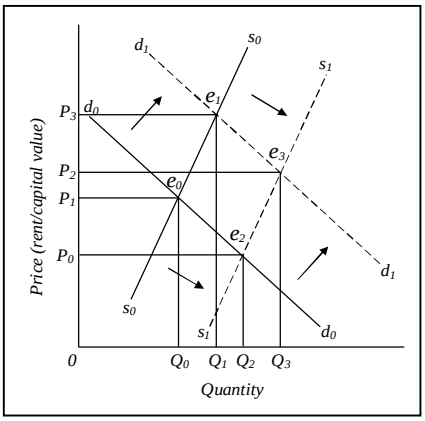

Fig. 6: Dynamic pricing of property

As indicated in Fig. 5, the supply of real estate in locations near city centres is perfectly inelastic such that prices are solely driven by changes in demand [3]. The situation in Fig. 5 is such that an increase in demand from d_0d_0 to d_1d_1 reflects a significant escalation of rents and sales prices from $0P_0$ to $0P_1$ in contrast with the outskirts of the urban area in Fig. 4.

Scarcity of landed property might trigger the situation in Fig. 5 such that the existence of a higher yielding alternative land use might induce price increases beyond the existing use value ceteris paribus. Scenarios in Figs. 4 and 5 are valid where there is no change in the supply of landed property. However, as supply responds to demand, developers shall be motivated to supply additional occupational and investment properties to meet market demand [3]. Although some scholars argue that the economic supply of landed properties in city centres may be perfectly inelastic, advancement in construction technology and a re-evaluation of economic viability of these city centres have successfully helped to debunk such claims over time [24, 25]. It is pertinent to recall the possibility of land reclamation from the sea let alone the possibility of erecting structures on similar water bodies.

Uncertainty in human behaviour towards land use over time can influence the conditions of demand and supply such that the equilibrium price exhibits dynamic changes as indicated in Fig. 6. At the initial supply curve, s_0s_0, the initial demand curve, d_0d_0 creates an equilibrium point, e_0 with corresponding price and quantity of $0P_1$ and $0Q_0$ respectively. If the market supply remains fixed at s_0s_0, an increase in quantity of property demanded from d_0d_0 to d_1d_1 shall create a new equilibrium point, e_1 with corresponding increase in price and quantity to the tune of $0P_3$ and $0Q_1$ respectively. Furthermore, it is irrational for the market to increase supply to s_1s_1 if demand for property remains at curve d_0d_0 as there is a tendency for a decrease in price from $0P_1$ to $0P_0$ in response to increase in quantity from $0Q_0$ to $0Q_2$. With reference to the equilibrium point e_1, an increase in the supply of landed property to s_1s_1 will engender a reduction in price from $0P_3$ to $0P_2$ coupled with an increase in quantity from $0Q_1$ to $0Q_3$ and the formation of a new equilibrium point, e_3. It can be inferred from Fig. 6 that any decision to sell property is most rational at the equilibrium point e_1, while it would be most favourable for buyers to purchase property at the equilibrium point e_2.

A review of the scenarios in Fig. 6 indicates that excess supply may trigger two major situations in property investment pricing. First, if demand for rented property remains at curve d_0d_0, rents may freeze for a while at $0P_1$ because excess landed property is supplied on curve s_1s_1. Thereafter, the market might respond by reducing rents from $0P_1$ to $0P_0$ to curb the incidence of voids. Similarly, if demand for rental property increases to d_1d_1 and supply remains static at s_0s_0, rents will increase to $0P_3$. Along the same demand curve, d_1d_1 excess supply of rental property along curve s_1s_1 will engender landlords/estate agents to freeze rents for a while in expectation that prospective tenants would further negotiate the asking rents. Inability of these landlords/estate agents to realize their expectations would lead to the downward review of equilibrium rent from $0P_3$ to $0P_2$.

Secondly, the scenario in Fig. 6 exerts impact on the pricing of property offered for sale. If the demand for investment property remains at curve d_0d_0, sales prices may freeze for a while at $0P_1$ as excess landed property is supplied on curve s_1s_1. Thereafter, the market will trigger a reduction in the price of the property from $0P_1$ to $0P_0$, indicating depression in the property market. If the demand for investment property increases to d_1d_1 and supply of the same property remains static at s_0s_0, sales price shall increase from to $0P_1$ to $0P_3$. Along the same demand curve, d_1d_1 excess supply of property along curve s_1s_1 will engender stagnation of prices for a while in expectation that purchasers would further negotiate the asking price. If this expectation is not realized by vendors, the market could compel a downward review of the equilibrium sales price of the property from $0P_3$ to $0P_2$, which signals depression in the property market.

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The definition of market value provided by Royal Institution of Chartered Surveyors (RICS) implies that it is a proxy for equilibrium price and should represent the basis for transaction in land and landed property [18]. In other words, the interaction between demand and supply has been adjudged the best form of pricing model for investment property [25]. However, as the property market is fraught with infrequent sales transactions, pricing models are only proxies to the outcome of the interaction between demand and supply functions [7, 18]. Assumed to have been embedded in these pricing models are market parameters, the behaviour of market participants, and the observable interaction between market forces of demand and supply. Notwithstanding the varying maturity of property markets around the world, property prices cannot fully capture all these information, which is why the property market is inefficient and requires valuation services to support purchase/sale decision-making. Nonetheless, most property analyst and investors might be satisfied with the assumption that some of these information are embedded in the pricing model to say the least.

Investors capitalize on available and privileged information about investments because it directs their ability to rationally execute tasks ranging from capital budgeting, asset allocation, portfolio restructuring and portfolio diversification to say the least. Evidences suggest that direct property investment market exhibits a weak form efficiency which makes it difficult for investors to earn abnormal returns [18, 26]. In response, a rational property investors would develop strategy for buying/selling underlying property assets in order to earn significant returns. In the same vein, a portfolio manager may be strategically concerned with the task of identifying underpriced property, while appropriate signals for asset allocation might be provided through valuation given its use as proxy for market information and investment parameters [18]. It may be possible that a synergy between growth explicit DCF and equivalent yield techniques would avert incidences of mispricing on the condition that methodologies for accurate assessment of nominal net equivalent yield are utilized.

III. ANALYTICAL FRAMEWORK

This section specifically addresses the synergy between growth explicit pricing models and equivalent yield analysis; the essence is to provide the analytical framework for assessing the implication of the methods of equivalent yield calculation on the pricing of under-rented freehold investment properties.

A. Equivalent yield valuation technique.

The conventional value models (Equations 1 - 6) upon which the use of equivalent yield is anchored have been examined in the preceding section. Among these equations, Equation 2 which pertains to the valuation of term and reversionary cash inflows (See Fig. 1) was chosen for this study to align with the growth explicit valuation of the same structure of cash inflows.

B. The growth explicit (DCF) pricing model.

The foundation of growth explicit DCF model is the ratio of the net cash inflow, c to the present value of the cash inflow or price, PV_0 otherwise call the all risk yield, k (Equation 8). Hence, for fully let freeholds,

$$k = \frac{c}{PV_0} \tag{8}$$

Furthermore, the price of a fully let freehold property is expressed as:

$$PV_0 = \frac{c}{k} \tag{9}$$

Alternatively, the formula for present value (price) of a stream of cash inflow is written as the sum the present value of each tranche of cash inflow, c:

$$PV_0 = \sum_{i=1}^{n} \frac{c}{(1+e)^i} \tag{10}$$

Equation 10 holds for an investment with n number of cash inflow tranches, i period per tranche, and a nominal discount rate of return otherwise called the equated yield, e. It can be expanded by incorporating income growth factor, g and rent review period, t [1], such that if $e > g$, the present value, PV is further expressed as:

$$PV_0 = \sum_{i=1}^{t} \frac{c}{(1+e)^t} + \sum_{i=1}^{t} \frac{c(1+g)^t}{(1+e)^{t+i}} + \sum_{i=1}^{t} \frac{c(1+g)^{2t}}{(1+e)^{2t+i}} + \ldots\ldots \infty \tag{11}$$

It was further acknowledged that Equation 9 culminates into a growth explicit pricing of property [1]. In which case Equation 12 ensues with the variables therein and retaining definitions that are synonymous to those in Equation 11 above:

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$$PV_0 = c\left(e - e\left(\frac{(1+g)^t - 1}{(1+e)^t - 1}\right)^{-1}\right) \tag{12}$$

A comparison of Equations 9 and 12 indicates the synergy between parameters of growth explicit models and the implicit all risks yield, *k* such that all the parameters that make up the value of *k* have been revealed as follows:

$$k = e - e\left(\frac{(1+g)^t - 1}{(1+e)^t - 1}\right) \tag{13}$$

Although Equations 9 to 13 are directly applicable to fully let freehold investment properties, it is pertinent to note that all risks yield of reversionary freeholds is distinct from its initial yield. In other words a different approach is applicable to the pricing of reversionary freehold property investment.

Notwithstanding that some scholars in the contemporary value models' school of thought have questioned the use of implicit yields in modern valuations [7, 8, 13, 17], it is worthy of note that such criticism need not arise provided the valuer has transparently deployed Equation 14, which describes the relationship among the parameters contained in this yield [1, 18, 20]. With reference to Equation 13, the reciprocal of this implicit all risks yield, *k* (Years' purchase of ordinary annuity in perpetuity) is expressed as:

$$\frac{1}{k} = \frac{1}{e}\left(\frac{(1+e)^t - 1}{(1+e)^t - (1+g)^t}\right) \tag{14}$$

With recourse to the Crosby's real value/short-cut DCF hybrid model, Equation 14 is fundamental to the valuation of reversionary cash flows. As a pricing model, the short-cut DCF hybrid model is expressed as:

$$PV_0 = \left(\frac{c}{e} - \frac{c}{e(1+e)^n}\right) + \frac{R(1+g)^n}{e(1+e)^n}\left(\frac{(1+e)^t - 1}{(1+e)^t - (1+g)^t}\right) \tag{15}$$

One of the advantages of Equation 15 is that it provides the framework for the pricing of both under-rented and over-rented freehold property investments [2, 27]. Adopted in this paper is an alternative approach to the short-cut DCF hybrid model which entailed the use of the algebra representing the symbol for the Years' purchase of ordinary annuity in perpetuity, 1/*k* as expressed in Equation 14 (See [8, 27, 28]). The ensuing variant of the short-cut DCF hybrid model is expressed as:

$$PV_0 = \left(\frac{c}{e} - \frac{c}{e(1+e)^n}\right) + \frac{R(1+g)^n}{k(1+e)^n} \tag{16}$$

Within the context of growth explicit DCF, Equation 16 implies that the price of a reversionary freehold property equals the sum of the present value of the term income, *c* and the present value of the reversionary income, *R*.

C. The decision rule.

Since Equations 15 and 16 are proxies for the actual prices payable for reversionary freeholds, an array of methodologies that seek to synergize these models with equivalent yield determination can be used to ascertain the extent to which each ensuing equivalent yields might lead to mispricing. The present value of cash inflows, PV_1 determined using the equivalent yield variant of the conventional techniques of valuation (Equation 2) was compared with the market price, PV_0 derived from the short-cut DCF technique (Equation 16). This was aimed at ascertaining the possibility of mispricing arising from equivalent yields determined with recourse to the methodologies indicated in Figure 3. For each methodology of equivalent yield determination, the difference between Equation 2 and Equation 16 symbolizes the Net Present Value (NPV) of a purchase decision, which implies that NPV equals PV_1 minus PV_0:

$$NPV = \left\{c\left[\frac{(1+y)^n - 1}{y(1+y)^n}\right] + R\left[\frac{1}{y(1+y)^n}\right]\right\} - \left\{\left(\frac{c}{e} - \frac{c}{e(1+e)^n}\right) + \frac{R(1+g)^n}{k(1+e)^n}\right\} \tag{17}$$

Equation 17 was used to draw inference pertaining to the outcome of a purchase decision. Within the context of property investment pricing using the Net Present Value (NPV) criterion, the decision rule is that the investment is-

1) underpriced if NPV > 0,
2) overpriced if NPV < 0,
3) correctly priced if NPV = 0,

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On the basis of NPV criterion, a property is underpriced (overpriced) if it is purchased at a price that is lesser (higher) than its market value [18]. Although rare in practice but theoretically achievable, the same property is correctly price if it was purchased at a price equivalent to its market value. The use of the NPV criterion is justified since direct yield to yield comparison cannot be established for growth explicit DCF- and equivalent yield techniques of valuation except for input cash inflows and the discounted outcomes (output).

IV. LOGICAL AND CONCEPTUAL JUSTIFICATION FOR EQUIVALENT YIELD APPRAISAL

The logical and conceptual justification for equivalent yield valuation and analysis have been debated over the years. The equivalent yield valuation technique entails the deployment of a single remunerative rate of interest as against two distinct yields for term and reversionary tranches of freehold cash inflows. The justification for the use of this single yield is anchored on the argument that analysis of yield would produce only one single yield [19]. The implication is that it is illogical to apportion different levels of risks to the term and reversionary tranches of cash inflows accruing to a single freehold investment [21]. Among the variants of conventional methods of property investment valuation, only the equivalent yield model is capable of adequately utilizing comparable information [8]. Nonetheless, one of the caveats is the significant divergence of subject property from the comparable property thereby diminishing the credibility of a valuation [8]. Except for specific categories of commercial properties, a cursory examination of property markets across the world indicates that comparable evidence is hard to come by. Even where such evidences exist, conventional valuation models are further exposed to valuers' intuitive adjustment of investment parameters. Among the advantages of equivalent yield valuation is the elimination of mathematical errors and intuitive adjustments of the term- and reversionary yields within the valuation [8]. Secondly, its objectivity in the analysis of transactions indicates that it is the only conventional technique capable of bridging the gap between conventional models and growth explicit DCF techniques of property investment appraisal [18].

Contrary to these advantages, a number of scholars have discredited the use of the conventional model of property investment valuation including the equivalent yield approach [7-10]. First they detested the application of implicit yield in valuing growth income. A careful comparison of term and reversion valuations ensuing from both equivalent yield- and growth explicit DCF models indicates over valuation of contract rent and undervaluation of market rent, which constitute a major snag with equivalent yield valuation. Although the summation of term and reversion values (capital values) may be similar for both models, scholars argued that such summation may becloud strategic investment decisions regarding contract- and market rents [8]. It has been argued that equivalent yield is implicit about rental growth and divergence between annuity in arrears or in advance thereby requiring the valuer's analytical skills towards curbing erroneous valuations. The position of this paper is that although the application of equivalent yield technique to market valuations may require some degree of choice of yield which may be subjective, a large proportion of underlying exercise to the valuation still relies on market intelligence and the expertise of the valuer. The second criticism hinges on accuracy of valuations and level of model sophistication. The equivalent yield technique has been acclaimed to produce accurate valuations notwithstanding its being implicit about property investment characteristics [18]. The argument is that since simple yield capitalization is based on the concept of discounted cash flow, the use of yields including equivalent yield in valuations implies the phenomenon of income growth such that sophistication in valuation models has nothing to do with accurate valuations but provides additional information that can improve strategic investment management decisions [18]. Thirdly, equivalent yield valuation model has been criticized for implicit handling of future rental growth [8]. Notwithstanding, there is a consensus that equivalent yield being a single growth implicit internal rate of return (IRR), reflects growth potential and the other investment risks applicable to a subject property in aggregate [8, 18]. The fourth argument was set to challenge the relevance of equivalent yield since there is scarcity of evidence to suggest that equivalent yield valuation technique currently reflect perceptions of property investors [8]. In defence, it could be observed that equivalent yield technique can reflect the perception of investors and remains a powerful tool for strategic property investment management especially when synchronized with growth explicit DCF techniques to determine pricing errors and other vital parameters to the advantage of investors. To seal the argument on the justification for equivalent yield valuation, it has been affirmed that if equivalent yield constitute a common terminology used by valuers, then its economic significant cannot be ruled out [18]. It is on the basis of this defence that this paper justifies the application of equivalent yield model to the pricing of reversionary freehold investment property.

Turning attention to equivalent yield analysis, it is possible to curb the emergence of mathematical errors if unnecessary approximation of yields is avoided. Furthermore, the use of appropriate methods of computing IRR would produce an equivalent yield which represents the IRR of nominal term and reversionary cash flows and compensate for the variation in these cash flows

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[18]. Beyond the accuracy of figures is a critical factor of the methodology of computation [3]. Hence, the method of calculating equivalent yield is viewed as a critical factor in the pricing decision that it is meant to support. It has been noted that equivalent yield analysis objectively captures data pertaining to its determining parameters [8]. It is on the basis of this statement that this paper demonstrates the objectivity of this choice of yield given its relationship with the parameters that were used to calculate it.

V. APPLICATION OF EXISTING METHODOLOGIES FOR EQUIVALENT YIELD CALCULATION

It has been argued that the variation in the content and structure of investment cash flows implies that there is no single formula for calculating the IRR [3], among which includes the equivalent yield. This section demonstrates with worked examples the six methods of calculating (nominal) equivalent yield of a freehold investment property (See Fig. 3). These methods include the use of Parry's Valuation and Investment Table; formula method; linear interpolation; the @IRR function of Microsoft Excel; the goal seek function in Microsoft Excel; and Solution to polynomial equation of *n*-degrees where $n \geq 2$.

A. Valuation data

A freehold property was let one year ago at a net rent of ₦1,050,000 subject to 3 yearly upward reviews. Current rental value of this property is ₦1,850,000 subject to 3 yearly upward reviews, investors overall discount rate is estimated at 21.5%, while implied rental growth rate is put at 13.75% p.a. Within the spreadsheet environment, Equation 16 was used to determine the sales price of the property.

The valuation in Exhibit 1 formed the basis for the outstanding objectives of this research comprising methods of equivalent yield calculation; accuracy of the computed equivalent yield; and application of the same yield to property pricing.

Exhibit 1: Price determination

		₦	₦
Term			
Rent received		1,050,000.00	
Y.P. for 2 years @ 21.5%		1.50044878	1,575,471.22
Reversion			
Market rent		1,850,000.00	
Amount of ₦1 in 2 years @ 13.75%		1.29390625	
Projected market rent		2,393,726.56	
Y.P. in Perpetuity @ 8.717837998%	11.47073392		
P.V. of ₦1 in 2 years @ 21.5%	0.677403512	7.770315444	18,600,010.48
Sales price			20,175,481.70

The methods for equivalent yield calculation were demonstrated using the empirical example of price determination posed in Exhibit 1.

B. Method 1: The use of Parry's Valuation and Investment Tables.

Valuation and investment tables are reference texts designed to provide snapshot figures representing the outcome of input parameters of an investment function. With recourse to the Parry's Valuation and Investment Table, equivalent yield is read from the table of IRR without growth [29]. The parameters required for the identification of the Equivalent yield in this table include the initial yield *i*, rent factor *F*, and the number of years to the next rent review.

The calculation is indicated as follows:

Input parameters

Initial yield, $i = \frac{net\ contract\ rent}{sales\ price} \times 100 = \left(\frac{1{,}050{,}000}{20{,}175{,}481.70} \times 100\right) \approx 5\%$

Rental factor, $F = \frac{net\ market\ rent}{net\ contract\ rent} = \frac{1{,}850{,}000}{1{,}050{,}000} \approx 1.8$

Years to next review = 2.

Tabulated Equivalent Yield

Page 188 of the Table indicates that an Equivalent yield (growth implicit IRR) estimate of **8.40%** is returned for an investment with the parameters analyzed on the Left Hand Side.

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VI. METHOD 2: THE FORMULA METHOD.

The formula method entails summing up the term rent and annual equivalent of gain on reversion and expressing it as a ratio of capital value of the property [3, 5]. Using the manual iterative process (trial and error), a reversionary yield of 9.3% shall be adopted to determine the earnings on reversion, *EOR*; while the annual equivalent of earnings on reversion, *AEOR*, shall be determined using 8% trial yield. The final answer is an IRR estimate of 8.495137%.

Earnings (Loss) on reversion = (₦1,850,000.00 × YP Perp. @ 9.3%) – ₦20,175,481.70 = -₦283,008.58

$$\text{Annual equivalent of earnings } (AEOR) = \frac{-₦283{,}008.58 \times \text{PV of } ₦1 \text{ in 2 years @ 8\%}}{\text{YP for 2 years @ 8\%}} = -₦136{,}061.82$$

$$\text{Equivalent yield} = \frac{1{,}850{,}000 - 136{,}061.82}{20{,}175{,}481.70} = 0.08495137$$

Therefore, equivalent yield = 8.495137%

VII. METHOD 3: LINEAR INTERPOLATION TECHNIQUE.

On the basis of the relationship between NPV and IRR, linear interpolation entails calculating a positive and a negative NPV arising from the application of the two distinct rates of interests and then using the principles of similar triangles to find an approximate equivalent yield, at which NPV = 0 [2, 4, 20]. Scholars have warned that NPV and IRR exhibits a geometric relationship as against the popular assumption of a linear relationship [18, 23]. Notwithstanding, the enormity of error in IRR calculation could be minimized if the difference between the dual rates of return is not more than unity. In addition, it was suggested that restriction should be placed on the expression of a linearly interpolated IRR in long decimal places on the grounds of less accurate results [23]. However, such suggestion was ignored in this study for the purpose of experimentation. Just as in the first, and second methods, the linear interpolation method tend to produce estimates of the IRR (equivalent yield). The linear interpolation model for IRR determination is expressed as:

$$IRR = R_1 + \left[\frac{NPV\ @\ R_1}{NPV\ @\ R_2 + NPV\ @\ R_1}(R_2 - R_1)\right] \quad (18)$$

Where R_1 is the trial rate that churns out positive NPV and R_2 is that trial rate that churns out negative NPV. The negative sign in the NPV @ R_2 is ignored to pave the way for computation of IRR. Trial rates of 8% and 9% were used to estimate the IRR.

	8% trial equivalent yield		₦	₦
	Term rent		1,050,000.00	
	Y.P. for 2 years @ 8%		1.783264746	1,872,427.98
	Reversion to market rent		1,850,000.00	
	Y.P. in Perp. @ 8%	12.5		
	P.V. of ₦1 in 2 years @ 8%	0.85733882	10.71673525	19,825,960.22
	P.V of cash inflow			21,698,388.20
Less	Price			20,175,481.70
	NPV @ 8%			1,522,906.51

	9% trial equivalent yield		₦	₦
	Term rent		1,050,000.00	
	Y.P. for 2 years @ 9%		1.759111186	1,847,066.75
	Reversion to market rent		1,850,000.00	
	Y.P. in Perp. @ 9%	11.11111111		

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	P.V. of ₦1 in 2 years @ 9%	0.841679993	9.351999925	17,301,199.86
	P.V of cash inflow			19,148,266.61
Less	Price			20,175,481.70
	NPV @ 9%			-1,027,215.09

$$\text{Equivalent yield} = 0.08 + \left[\frac{1{,}522{,}906.51}{1{,}027{,}215.09 + 1{,}522{,}906.51}(0.09 - 0.08)\right] = 8.597189761\%$$

VIII. METHOD 4: THE @IRR FUNCTION OF SPREADSHEETS (MICROSOFT EXCEL).

Summarized in Exhibit 2 are the information required in a spreadsheet environment for the actual calculation of equivalent yield. Among the requirements for Microsoft Excel to perform a robust @IRR calculation was the use of a personal computer installed with 64-bit Windows 7 Ultimate operating system and possessing not less than 60 Gigabyte of free hard drive space and 8GB of Random Access Memory. Within the Microsoft Excel 2007 environment (Fig. 7), the sales price was set at the gestation period – Year 0, while the contract rent of ₦1,050,000 earned over the duration of 2 years was imputed in cells *C3* and *C4* respectively. Furthermore, the market rent of ₦1,850,000 was extended to 283 years as proxy for its being perpetually earned from the investment, after which the @IRR function was expressed as @IRR(C2:C283) in the cell *C285* to return the equivalent yield (IRR).

Exhibit 2: Cash flow profile of property

Year	Cash flow (₦)
0	-20,175,481.70
1	1,050,000
2	1,050,000
3 - Perp	1,850,000

Upon execution, the @IRR function returned an equivalent yield (IRR) of 8.56836383% (Fig. 7). It was observed that an extension of reversionary cash flows beyond cell C285 to say C7449 did not significantly change the IRR (equivalent yield). However, a "#DIV/0!" error was returned the moment IRR calculation was attempted for reversionary income beyond the cell C7449, implying that the ensuing IRR is large number.

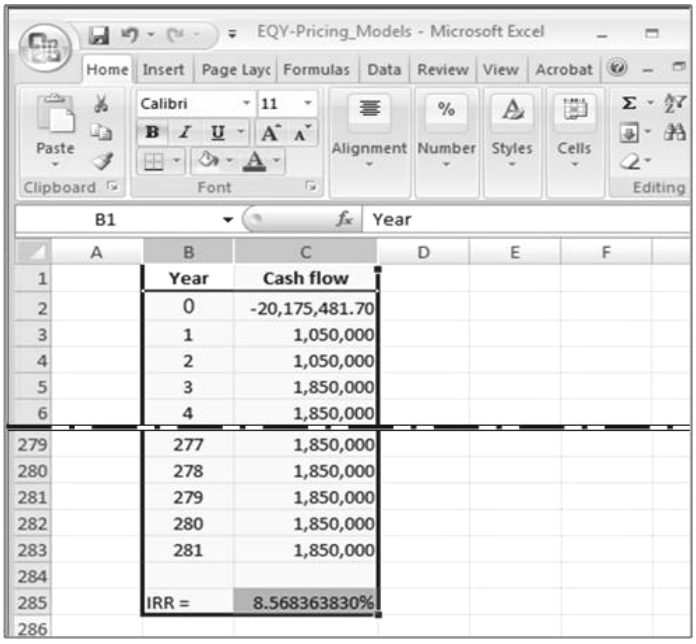

Fig. 7: Equivalent yield determined from @IRR function in Excel

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In other words, the cut-off cell for cash flows in Fig 7 that was used to determine equivalent yield is C7449, which represents a total period of 7,447 years. At this cut-off cell, the equivalent yield remained 8.56836383%.

IX. METHOD 5: THE GOAL SEEK FUNCTION IN SPREADSHEETS (MICROSOFT EXCEL).

A number of texts have explained the principle of the goal-seek tool of Microsoft Excel and how it can be used to calculate IRR of property investments (See [3, 22, 23]). It is an extension of the "What-If Analysis" function available to investment analyst who are interested in performing scenario analysis. For the goal seek calculation, personal computer with the same specification as that mentioned in the preceding section was deployed.

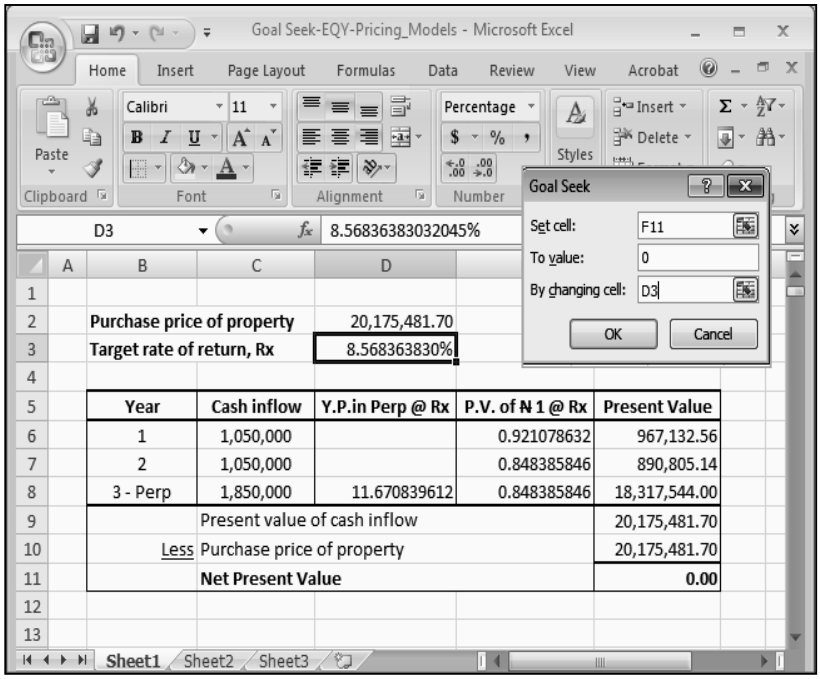

Fig. 8: Equivalent yield determined using goal seek function in Excel

A framework for DCF appraisal was first set up in Microsoft Excel (Fig. 8), then the NPV cell "F11" was set to ₦0.00, while the cell "D3" was inserted into the form tagged - "By changing cell". After clicking the "OK" button, the goal seek command returned equivalent yield (IRR) of 8.56836383% for the DCF appraisal as indicated in Fig. 8.

X. METHOD 6: SOLUTION TO POLYNOMIAL EQUATION OF N-DEGREES WHERE N ⩾ 2.

The valuation data was transformed into a system of polynomial function for which solution to a single unknown root that satisfies the range $0 < r < 1$ can be determined. In other words, the root of the ensuing polynomial equation that reflects the actual and rational IRR for the property investment was isolated and reported. While there are certain proprietary software packages that solve and isolate the appropriate root of the polynomial equation, it is at the discretion of the appraiser to verify the correctness of the root of the polynomial in the light of equivalent yield since it is possible to obtain multiple roots from this exercise [18].

Within the context of this exercise, the valuation data for the investment property in focus was expressed in the form of Equation 2:

$$\frac{1{,}050{,}000\left[(1+r)^2-1\right]}{r(1+r)^2}+\frac{1{,}850{,}000}{r(1+r)^2}=20{,}175{,}481.70 \quad (19)$$

Equation 19 was alternatively expressed in the form of a third-degree polynomial function as follows:

$$f(r) = 20175481.7r^3 + 39300963.4r^2 + 18075481.7r - 1850000 \quad (20)$$

The values of f(r) represents the NPV of the investment property at successive values of the target rate of return, r so that equivalent yield (IRR) can be determined by solving for the zeros (roots) of Equation 20. To qualify as the growth implicit IRR within this context, the root of the polynomial function (Equation 20) is expected to be a positive non-integer (decimal) which could be further

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expressed in percentage. Version 2.0 of the KyPlot® software was used to determine the roots of Equation 20. Although this software package has been acclaimed for its integrated data analysis and graphical visualization [30], its application in this study was driven by its embedded root-finding algorithm for polynomial equations.

With recourse to the Math tool bar in KyPlot®, the roots of Equation 20 was found to include a positive non-integer of 0.0856836383, and two imaginary roots comprising -1.0168 - 0.19037*i* and -1.0168 + 0.19037*i* respectively. These imaginary roots have been discarded in favour of the positive non-integer, 0.0856836383. Furthermore, the Graph tool bar of KyPlot® was used to plot Equation 20 within the range: $-6 \leq r \leq +6$, (Fig 9). However, this positive non-integer root of the function could only be visualized following the graphing, embedding and mapping of the magnified version onto the initial graph (Fig. 9). It is inferred that this method puts the equivalent yield (growth implicit IRR) of the investment property at 8.568363830% (correct to 9 decimal places).

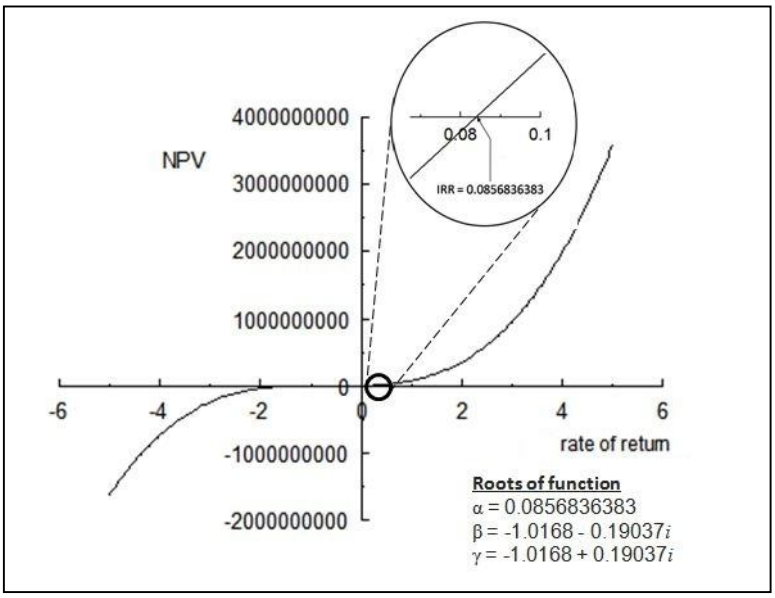

Fig. 9: Graphical solution to Equivalent yield determination

Although this method of equivalent yield calculation produces accurate result; it is fraught with difficulty when manual computation is engage, let alone the possibility of encountering multiple roots. At this juncture, the first problem has been surmounted using mathematical software packages that have embedded root-finding algorithms, while the second problem can be ameliorated through the exercise of commonsense.

For the same property investment data, it was observed that methods 1, 2, and 3 determined the equivalent yield as 8.40%, 8.495137%, and 8.597189761% respectively, while methods 4, 5, and 6 produced similar equivalent yields of 8.568363830% respectively. Having demonstrated the methods of equivalent yield calculation, the succeeding sections examined these calculated equivalent yields on the basis of accuracy and the corresponding impacts they exert on property investment pricing.

XI. ACCURACY OF EQUIVALENT YIELDS ARISING FROM THESE METHODOLOGIES

From a theoretical perspective, the accuracy of equivalent yield is tested with recourse to a valuation that is likely to equate with sales price. Contrary to this proposition, scholars do not see the possibility of valuations equating with sales price following the imperfection and inefficiency of the property market [7]. Nevertheless, there has been no study to investigate how the accuracy of equivalent yield could influence the outcome of property investment pricing. It is possible that a good number of property scholars with bias for the analyses of yield parameters are not so much concerned with this issue on the premise that approximate yield figures are good enough to aid investment decision-making, which is viewed in the context of this paper as a misnomer. During exams, students taking modules in property investment valuation/appraisal may be pardoned for adopting less accurate methodologies or for rounding-off yields and investment indices to say four decimal places since the course tutor may allow for tolerable margin of errors. However, an investment appraiser in practice should know that (s)he may not be easily pardoned for

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similar oversights because the client might expect a sound investment advice that is anchored on accurate analysis of yield parameters.

To achieve the third objective of this study, equivalent yields that have been calculated using variants of existing methodologies in the preceding section were deployed in the conventional valuation model (Equation 2) on a case-by-case basis with a view to determine the likely pricing decision that may arise from the use of such yields.

A. Test of Equivalent yield from Method 1.

Method 1 produced an equivalent yield of 8.40%. The present value of interest in the property at this yield is put at ₦20,640,938.53 (Exhibit 3), which exceeds the market price of ₦20,175,481.70.

Exhibit 3: Valuation using 8.40% equivalent yield

		₦	₦
Term rent		1,050,000.00	
Y.P. for 2 years @ 8.40%		1.773532495	1,862,209.12
Reversion to market rent		1,850,000.00	
Y.P. in Perp. @ 8.40%	11.90476190		
P.V. of ₦1 in 2 years @ 8.40%	0.85102327	10.13122941	18,742,774.41
Present value of cash inflows @ 8.40%			20,604,983.53

B. Test of Equivalent yield from Method 2.

Method 2 produced an equivalent yield of 8.495137%. The present value of interest in the property at this yield is put at ₦20,360,179.60 (Exhibit 4), which exceeds the market price of ₦20,175,481.70.

Exhibit 4: Valuation using 8.495137% equivalent yield

		₦	₦
Term rent		1,050,000.00	
Y.P. for 2 years @ 8.495137%		1.771231735	1,859,793.32
Reversion to market rent		1,850,000.00	
Y.P. in Perp. @ 8.495137%	11.77144053		
P.V. of ₦1 in 2 years @ 8.495137%	0.84953144	10.00020880	18,500,386.27
Present value of cash inflows @ 8.495137%			20,360,179.60

C. Test of Equivalent yield from Method 3.

Method 3 produced an equivalent yield of 8.597189761%. The present value of interest in the property at this yield is put at ₦20,103,643.88 (Exhibit 5), which is less than the market price of ₦20,175,481.70

Exhibit 5: Valuation using 8.597189761% equivalent yield

		₦	₦
Term rent		1,050,000.00	
Y.P. for 2 years @ 8.597189761%		1.768769658	
Reversion to market rent		1,850,000.00	
Y.P. in Perp. @ 8.597189761%	11.63170789		
P.V. of ₦1 in 2 years @ 8.597189761%	0.84793552	9.86293824	18,246,435.74
Present value of cash inflows @ 8.597189761%			20,103,643.88

D. Test of Equivalent yield from Methods 4 and 5.

Within the spreadsheet environment, methods 4 and 5 produced an equivalent yield of 8.56836383%. The present value of interest in the property at this yield is put at ₦20,175,481.70 (Exhibit 6), which equates the market price of ₦20,175,481.70

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Exhibit 6: Valuation using 8.56836383% equivalent yield

		₦	₦
Term rent		1,050,000.00	
Y.P. for 2 years @ 8.56836383%		1.769464477	1,857,937.70
Reversion to market rent		1,850,000.00	
Y.P. in Perp. @ 8.56836383%	11.67083961		
P.V. of ₦1 in 2 years @ 8.56836383%	0.84838585	9.90137513	18,317,544.00
Present value of cash inflows @ 8.568363830%			20,175,481.70

E. Test of Equivalent yield from Methods 6.

With recourse to the zeros of a polynomial representing the equivalent yield of the property (8.56836383%), the present value of interest in the property was also put at ₦20,175,481.70 (Exhibit 6), which equates the market price of ₦20,175,481.70

With reference to the valuation exhibits above, methods 4, 5, and 6 produced accurate equivalent yields contrary to methods 1, 2, and 3. Besides the exercise of precautions in the approximation of input and output parameters, the accuracy of equivalent yield analysis is applauded when the exercise is performed using computerized approaches. The essence is to curb the abuse of non-integers in the numerical value of investment parameters for multi-million or multi-billion Naira worth of individual property or property portfolios which could override objective decision-making.

XII. IMPLICATIONS OF COMPUTED EQUIVALENT YIELDS ON PRICING DECISIONS

The valuations in Exhibits 1 to 5 have specific implications for property investment pricing following the import of the decision-rule for this exercise. Information that were tabulated in the bid to address the fourth objective of this study include each method of equivalent yield calculation and their respective nominal net equivalent yield (NNEY), true net equivalent yield (TNEY), value of property at the nominal net equivalent yield (PV_1), price paid for the property's growth explicit cash flow (PV_0), NPV of purchase decision, and a statement indicating the implications on pricing decision (Table I). With recourse to Equation 7, the TNEY in this paper symbolizes the equivalent yield of annual cash inflow received in advance, where the frequency of cash flow receipt, $m = 1$ and *"r"* symbolizes the nominal net equivalent yield.

The use of Parry's valuation and investment tables returned NNEY of 8.4% with a corresponding TNEY of 9.170305677%. For the subject property, the NPV at 8.4% NNEY is put at ₦429,501.83, implying that it is underpriced in consonance with the decision rule (NPV > 0). Therefore, the use of valuation and investment tables (Method 1) led to the underpricing of the freehold investment property.

TABLE I
PRICING IMPLICATION OF METHODS OF EQUIVALENT YIELD CALCULATION

Method of EY calculation	NNEY (%)	TNEY (%)	Capital value @ NNEY (PV_1)	Price paid for property (PV_0)	NPV (PV_1 - PV_0) (₦)	Symbolic remarks	Investment pricing implications
Valuation table	8.40	9.170305677	20,604,983.53	20,175,481.70	429,501.83	NPV > 0	Underpriced
Formula method	8.495137	9.283809321	20,360,179.60	20,175,481.70	184,697.90	NPV > 0	Underpriced
Linear interpolation	8.597189761	9.405826515	20,103,643.88	20,175,481.70	-71,837.82	NPV < 0	Overpriced
@IRR in MS Excel	8.568363830	9.371333806	20,175,481.70	20,175,481.70	0.00	NPV = 0	Correctly priced
Goal seek in MS Excel	8.568363830	9.371333806	20,175,481.70	20,175,481.70	0.00	NPV = 0	Correctly priced
Zeros of polynomial	8.568363830	9.371333806	20,175,481.70	20,175,481.70	0.00	NPV = 0	Correctly priced

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Secondly, the formula method returned NNEY of 8.495137% with a corresponding TNEY of 9.283809321%. For the subject property, the NPV at 8.495137% NNEY is put at ₦184,697.90, implying that it is underpriced in consonance with the decision rule (NPV > 0). Therefore, the formula method (Method 2) underpriced the same freehold investment property.

Thirdly, linear interpolation method returned NNEY of 8.597189761% with a corresponding TNEY of 9.405826515%. For the subject property, the NPV at 8.597189761% NNEY is put at -₦71,837.82, implying that it is overpriced in consonance with the decision rule (NPV < 0). Therefore, the linear interpolation method (Method 3) culminated into the overpricing of the subject property.

The @IRR and goal seek techniques are both spreadsheet integrated approaches to the calculation of IRR. Within the MS Excel environment, both techniques returned NNEY of 8.568363830% with a corresponding TNEY of 9.371333806% for the subject property. Within the context of these two techniques, the NPVs of the subject property at 8.568363830% NNEY were precisely determined as ₦0.00, implying that the property is correctly priced in consonance with the decision rule (NPV = 0). Following this result, these two spreadsheet-integrated techniques have contributed to the correct pricing of the freehold investment property.

The use of a mathematical software package with in-built root-solving algorithms returned a logical value of 8.568363830% for NNEY which translates to TNEY of 9.371333806% for the subject property. The NPV of the same property at 8.568363830% NNEY was precisely calculated as ₦0.00, implying that the property is correctly priced in consonance with the decision rule (NPV = 0). Being a mathematical approach to equivalent yield analysis, method 6 is capable of contributing to the correct pricing of an investment property just as the @IRR and the goal seek techniques.

Attention of this study was finally drawn to the winners and losers in the process of property investment pricing and the optimal decision that the gainers might likely take as indicated in Table II. The vendee of underpriced properties are the gainers while the losers are the sellers (vendors). On the other hand, the vendors of overpriced properties are the gainers while the losers are the vendee (purchasers). With recourse to Table II, it has been suggested that asset allocation decision of investors should be anchored on the selection of underpriced properties [18]. The rationale for this phenomenon had been attributed to information asymmetry which drives one party to a property transaction to use market information to take advantage of the other party whose available information might have lagged behind current market trend [2, 18, 31].

TABLE II
WINNERS AND LOSERS IN THE PROCESS OF PROPERTY INVESTMENT PRICING

NPV	Pricing outcome	The Gainers	The losers	Optimal decision of gainers
NPV > 0	Underpriced	Vendee	Vendor	Buy
NPV < 0	Overpriced	Vendor	Vendee	Sell
NPV = 0	Correctly priced	Nil	Nil	Hold

Although rare in practice but theoretically feasible, there is neither a winner nor loser in the market for a correctly priced property such that the portfolio investor might decide to retain the property investment. Within the context of this study, it has been observed that the methodology for the calculation of yield parameters (especially the equivalent yield) might contribute to mispricing which may either be to the advantage of the vendor or the vendee. This finding adds to the importance of property investment pricing on the basis of appropriate processing of information as observed by Brown and Matysiak [18]

XIII. CONCLUSION

This study provided an assessment of how the methodologies for equivalent yield calculation can influence the pricing of under-rented freehold property investments. The conceptual justification for equivalent yield is that it is comparable to that single yield that indicates the entire risk associated with both the term and reversionary cash inflows of an investment. It is logically acceptable that the analysis of entire tranches of cash flows of any investment can only produce a single redemption yield contrary to the situation whereby term and reversionary cash flows are apportioned different risk profiles and yields respectively. An assessment of the existing methods of equivalent yield calculation indicates that the use of software applications with root-finding algorithms, and spreadsheet tools of goal seek- and the @IRR tend to produce similar and accurate results compared to the use of valuation and investment tables, formula method, and linear interpolation, which are adjudged to be outdated. It was observed that the methodology for yield analysis exerts impact on the accuracy of the equivalent yield. In addition, yields from each methodology were found to have significant impact on the outcome of a pricing decision. As indicated in Table I, correct pricing of the subject property ensued following the use of equivalent yields derived from the spreadsheet- and polynomial root-solving approaches. On

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the other hand, overpricing occurred when the linear interpolation method was used to calculate equivalent yield for the same property. In addition, underpricing of the same property ensued following the valuation of cash flows at equivalent yields derived from valuation and investment tables, and the formula method respectively. The implication of these results in practice is the possibility of these outdated techniques to trigger mispricing in the sense that buyers (sellers) of underpriced (overpriced) properties are likely to gain at the expense of sellers (buyers) of the same properties, besides other existing factors of information asymmetry that these market dealers might use to outsmart themselves. Therefore, the application of the spreadsheet approaches (goal seek and @IRR functions) and software with in-built root-finding algorithm are recommended as probable means of achieving accuracy of investment parameters that further constitute indicators for the correct pricing of under-rented freehold property investments.

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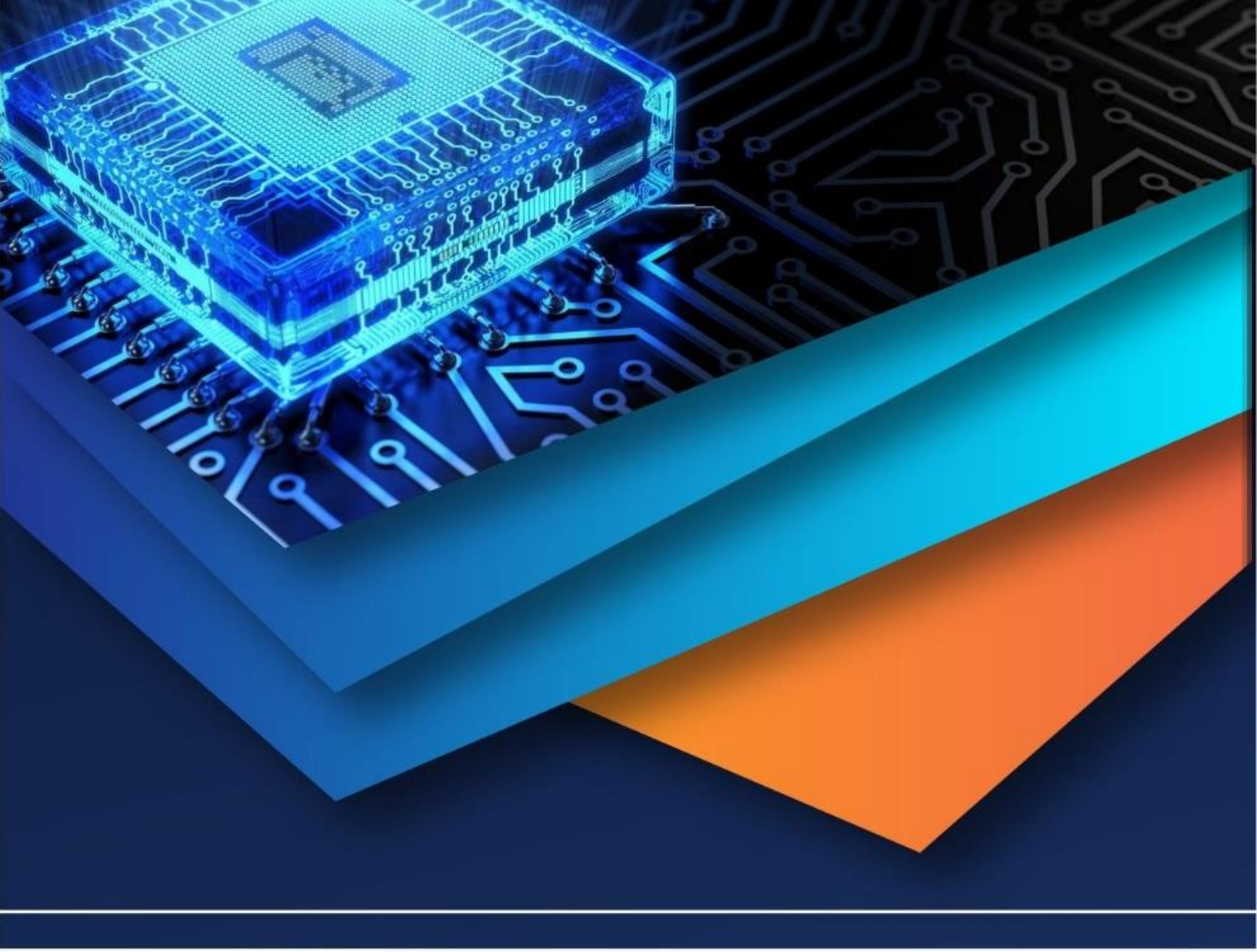

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